

Probing Phonons in Plutonium using High Resolution Inelastic X-ray Scattering⁽¹⁾

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ABSTRACT

The phonon spectra of plutonium and its alloys have been sought after in the past few decades following the discovery of this actinide element in 1941, but with no success. This was due to a combination of the high neutron absorption cross section of ^{239}Pu , the common isotope, and non-availability of large single crystals of any Pu-bearing materials. We have recent designed a high resolution inelastic x-ray scattering experiment using a bright synchrotron x-ray beam at the ESRF, Grenoble and mapped the full phonon dispersion curves of an fcc δ -phase polycrystalline Pu-Ga alloy. Several unusual features including, a large elastic anisotropy, a small shear elastic modulus C' , a Kohn-like anomaly in the $T_1[011]$ branch, and a pronounced softening of the $[111]$ transverse modes are found. These features can be related to the phase transitions of plutonium and to strong coupling between the lattice structure and the 5f valence instabilities. Our results also provide a critical test for theoretical treatments of highly correlated 5f electron systems as exemplified by recent dynamical mean field theory (DMFT) calculations for δ -plutonium.⁽²⁾

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1. Wong et al. Science, **301**, 1078 2003
 2. Dai et al. Science, **300**, 953 2003.